THE MODERATING ROLE OF AGEING GROWTH ON THE IMPACT OF DEMOGRAPHIC FACTORS ACROSS THE ITALIAN PROVINCES

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Abstract. In Italy, the ageing process varies from one province to another, with some ageing faster than others. At the beginning of the 2000s, the country was divided into two groups: the southern and island provinces were younger, while the central and northern provinces were more advanced. In the following years, the younger provinces experienced a greater increase in the mean age, reducing the demographic differences between the macro-areas. This study aims to assess whether and how the contribution of the demographic components, i.e. fertility and migration, to the slowdown in ageing differs according to the speed of the phenomenon over the period 2002-2022.
The provinces were divided into groups according to the quartile of the mean age growth rate and regression models were implemented in which the speed of ageing is considered as a moderating variable that can influences the strength of the relationship between an independent and a dependent variable and then entered through an interaction term.
The results show that fertility is crucial in slowing down ageing, with a greater impact than migration. The fertility of Italian women has a predominant influence on the mean age, while that of foreign women has a less pronounced effect. The presence of foreigners, although increasing, does not compensate for the effects of demographic ageing. Furthermore, the speed of ageing creates differences in the impact of fertility and migration on mean age, with their impact increasing as the speed of ageing increases.

1. Introduction

The ageing of the population is one of the most important demographic phenomena of this century (Bloom and Luca, 2016). Italy is continuing the ageing process that began decades ago (Kinsella and Phillips, 2005); the share of the elderly population is constantly increasing, now, the population aged 65 and over represents 24.1% of the total population. Since 2002, this share has increased by 5,4 percentage points. In the same period, the share of the youngest population under 15 years of age, has fallen by almost 2 percentage point and now represents 12.5% of the population (ISTAT, 2023). The country's demographic dynamics have been characterised by a negative natural balance since the early 2000s. The peninsula has rapidly become one of the oldest countries in the world (Bagautdinova *et al.*, 2014) and the oldest country in Europe (Eurostat, 2021), attracting the attention of politicians and academics looking for the most effective solutions to slow down this unprecedented process. However, Italian territories have not all aged in the same

way, emerging significant territorial disparities (García-Pereiro, 2018). Demographic changes in the age structure have occurred more rapidly and intensively in previously younger areas such as the territories of southern Italy (Golini *et al.*, 2003). Over time, territories have tended to converge towards a similar mean age (Kashnitsky *et al.*, 2017).

The extensive literature on ageing is increasingly considering the significance of territorial differences in this process. However, the concept of the speed of ageing has yet to be fully explored. Our contribution to the existing literature is to link the growth rate of ageing to the analysis of its demographic determinants, thus offering a more comprehensive and in-depth view of both the causes and the results of the phenomenon. The aim of this study is to examine whether and how the contribution of the different demographic components to the slowdown in ageing varies in relation to the speed of evolution of the phenomenon.

2. Literature review

One of the causes of population ageing is the decline in fertility (Bengtsson and Scott, 2010). Coale (1957) showed that prolonged low fertility produces an ageing population and that the level of mortality has a secondary effect on the age distribution of the population compared to the effect that fertility may have. The ageing of Italy is therefore a direct consequence of persistently low fertility levels. A country is considered to have a very low fertility level if its total fertility rate falls below 1.5 children per woman (Lesthaeghe and Willems, 1999). It has been observed that in countries with low fertility, migration flows can be viewed as a means of "replacing" the lack of births in the native population and of coping with the ageing of the overall population. (Bagavos, 2019; Wilson et al., 2013; Billari and Dalla Zuanna, 2011). In the Italian context, García-Pereiro and Paterno (2022) compared the contributions made at the provincial level by both fertility and migration in the rapid ageing process underway in the country. The findings demonstrated that both factors contribute to the observed variability in the mean age, with fertility exerting a more pronounced influence.

The dynamics of this phenomenon vary depending on the geographical area (Schoeni and Ofstedal, 2010). Recently, investigations of population ageing and its connection to space have become more widespread than in the past. A significant proportion of these studies have concentrated on the contrasting patterns of the phenomenon's development between urban and rural municipalities[1] (Heleniak,

[1] Ageing and urbanization are seen as the two main transitions of developed populations (Beard and Petitot, 2010). Urbanized regions tend to attract people of working ages, while rural regions are left with a higher proportion of people out of the labour market (Smailes et al., 2014). This comparison is particularly interesting considering the different levels of urbanisation between northern and southern Italian provinces. However, this aspect is not part of the objectives of this research.

2003; Moore and Pacey, 2004; Walford and Kurek, 2008; Gutiérrez Posada *et al.*, 2018; Backmana and Karlssona, 2023). Despite differences in the speed of development between the areas, over time all territories tend to converge to a similar level with each other (Kashnitsky *et al.*, 2017). Golini *et al.* (2003) examined the correlation between the percentage of elderly people observed in 2001 in the Italian regions and the estimated rate of increase of the elderly population from 2001 to 2021 in each region. The findings suggest that the process of population ageing will occur at a faster and more pronounced rate in Italy's southern regions, which are characterised by a younger demographic structure, in comparison to the northern regions, which are characterised by an older population. Furthermore, the rate of this transformation is found to increase as one moves towards regions with a low share of the elderly population. Reynaud *et al.* (2018) examined the evolution of population ageing between 2002 and 2014 across Italian provinces. The findings indicated a tendency towards a convergence of age structures, accompanied by a notable reduction in the initial disparities observed in 2002. The southern and island provinces exhibited a significantly younger population than those in the north-west, north-east and centre. However, during the period under review, a marked increase in the old-age index was observed in the southern and island provinces, in contrast to a slower dynamic in the northern and central regions, where some provinces even experienced demographic rejuvenation. The territorial differences of ageing in Italy are considerable, both within the main socio-economic regions and within regions or provinces (Basile *et al.*, 2022).

Given the heterogeneous nature of the ageing phenomenon in Italy, the impact of fertility and migration on ageing may vary considerably at the local level. The aim of this study is to assess whether and how the contribution of these demographic components to the slowdown in ageing differs according to the speed at which the phenomenon evolves over the period 2002-2022. In particular, we want to answer the following research questions: RQ1: How do fertility and migration contribute to the ageing process? RQ2: Is the contribution of fertility greater in provinces that have experienced faster ageing? RQ3: Is the contribution of migration greater in provinces that have experienced faster ageing?

3. Data and method

A data set was constructed using data provided by the National Institute of Statistics at the NUTS2 level for the period from 2002 to 2022. For each Italian province, data were collected on the demographic phenomena of interest, namely fertility and immigration. Among the various measures available for assessing population ageing, we selected the mean age of the population, in accordance with the research conducted by Garcia-Pereiro and Paterno (2022). Moreover, as demonstrated by the studies conducted by Murphy (2017), the utilisation of this

indicator in comparison to other available measures, e.g. the percentage of elderly persons 65+, does not result in any significant discrepancies in the interpretation of the findings. In our analysis, the total fertility rate (TFR) of Italian women was used as a basis for examining fertility trends[2]. While, in order to assess the impact of international migration, two key aspects were considered: firstly, the TFR of foreign women[3] was employed as a measure of their potential contribution to the country's fertility; secondly, the percentage of the resident foreign population[4] in each province was quantified in order to consider the volume of this population.

In order to answer research questions 2 and 3, i.e. to check whether the contribution of fertility and migration varies with the speed of ageing, it was necessary to have a measure that could quantify the development of the phenomenon over time. In the context of studies on ageing, the annual rate of increase of ageing measures (Nagarajan *et al.*, 2020; Lee, 2003) has been commonly employed to assess the advancement of the phenomenon. In light of these studies, we have choose to use it to measure the speed with which ageing progressed from 2002 to 2022 in the Italian provinces. To this end, we have calculated the geometric rate of increase in the mean age as follows:

$$GR_i = \left(\frac{Mean\ Age_{i,2022}}{Mean\ Age_{i,2002}}\right)^{\frac{1}{20}} - 1 \quad (1)$$

A twenty-year rate was chosen to avoid random fluctuations due to specific periods (e.g. the COVID-19 pandemic). In addition, changes after only one year may not be significant, as ageing typically develops over the long term.

In our study, this growth rate represents the percentage change in the mean age of the resident population between the years 2002 and 2022. The mean age of the Italian population increased by approximately 5% on average, from 41.9 years in 2002 to 46.2 years in 2022. The provinces were then classified according to the

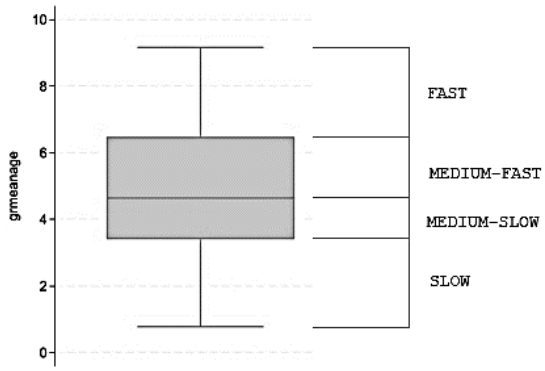
[2] There are notable disparities in fertility trends across Italy's macro-areas, with the North and South displaying contrasting patterns. In the northern and central regions of Italy, the TFR of Italian women exhibited an upward trajectory from the 2000s until 2010, when it began to decline to its current levels. Conversely, the TFR at the outset of the period was higher in the South than in the North, remaining relatively constant with some fluctuations until 2010. Subsequently, a decline in TFR values was also observed in this part of the country.

[3] The trend in the total fertility rate (TFR) of foreign women shows a decline at the national level, with differences in intensity between the different macro-regions. In particular, the fertility of foreign women is higher in the northern regions than in the other macro-regions.

[4] Since the beginning of the period under consideration (2002), the percentage of foreigners has increased throughout the country, with significant differences between the north and the south. The northern and central provinces have experienced exponential growth in the foreign presence, while the southern provinces have seen more moderate growth. Currently, the percentage of foreigners in northern Italy is about 10%, which is more than twice as high as in southern Italy, where it stands at around 4%.

quartiles of the distribution of the mean age growth rate (Figure 1) as follows: Fast Ageing (provinces with a growth rate of ageing in the upper quartile; 6.45 – 9.16), Medium-Fast Ageing (provinces with a growth rate between the median and the third quartile; 4.63 – 6.45), Medium-Slow Ageing (provinces with a growth rate between the first quartile and the median; 3.4 – 4.63) and Slow Ageing (provinces with a growth rate of ageing in the lower quartile; 0.77 – 3.4). This classification enables the identification and comparison of the differential impact of fertility and migration on mean age, depending on the rate of ageing.

Figure 1 – *Box Plot growth rate of mean age for Italian provinces.*



Source: Our elaboration based on ISTAT data

We decided to implement a series of OLS (Ordinary Least Squares) regression models, as *shown in Table 1*, where the dependent variable is the mean age in the provinces and the choice of independent variables varies according to the research question to be answered. The M1 model is designed to answer research question RQ1 by including the TFR of Italian women, the TFR of foreign women and the percentage of foreign population as independent variables.

To answer research questions RQ2 and RQ3, i.e. to test whether the impact of fertility and migration on population structural change varies with the growth rate of the mean age, we treat the latter as a moderator variable. A moderator is defined as a variable that influences the strength of the relationship between an independent and a dependent variable (James and Brett, 1984). The treatment of a moderator variable in a statistical model implies the inclusion of an interaction term between the moderator variable and the independent variable of interest, which makes it possible to test whether the relationship between the independent variable and the dependent variable changes as a function of the values of the moderator variable.

Table 1 – *Description of the models.*

	M1	M2	M3	M4
Dependent variable	Mean age	Mean age	Mean age	Mean age
Independent variables	TFR Italian women TFR foreign women Percentage of foreigners	TFR of Italian women	TFR foreign women	Percentage of foreigners
Moderator variable		Growth rate of the mean age	Growth rate of the mean age	Growth rate of the mean age

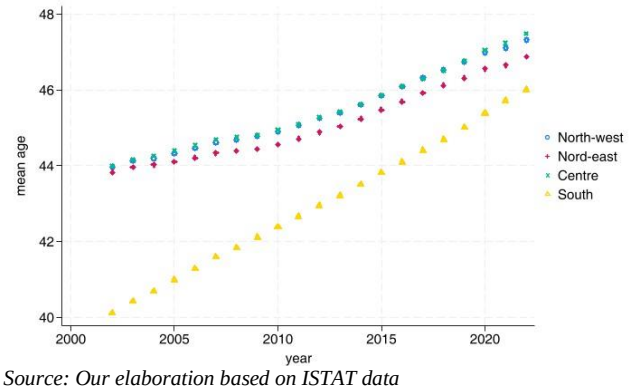
The M2 model is designed to answer RQ2 by including the variable TFR of Italian women. Questions RQ3 are addressed in models M3 and M4, which analyse the fertility contribution of foreign women and the foreign presence through the percentage of foreign population, respectively. It is therefore included in the M2, M3 and M4 models the interaction term with the growth rate of the mean age, which allows us to test whether and how the impact of fertility and migration differs between provinces with different ageing speed.

4. Results

The demographic evolution of ageing was observed across the entire national territory, with a notable increase in the mean age, particularly pronounced in the southern and island regions as illustrated in Figure 2. It demonstrates that the territorial differences in ageing between southern and northern Italy has diminished over time. At the outset of the study period, provinces in Northern and Central Italy had a mean age four years higher than those in the South and Islands. However, due to the accelerated ageing process in the southern provinces, the maximum difference in mean age between the macro-areas is now less than two years.

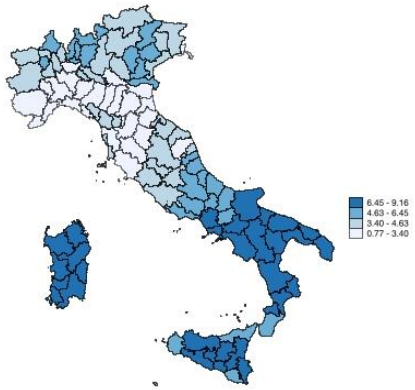
Figure 3 shows the Italian provinces classified according to the speed of ageing. The provinces in dark blue belong to the FAST category, having experienced a greater increase in the mean age, while those in light blue belong to the SLOW category, having experienced a smaller increase. It is clear that the southern provinces, which were among the youngest in 2002, have experienced rapid ageing. In contrast, the northern provinces experienced a more moderate increase in the mean age. These differences in the rate of ageing indicate a trend towards demographic homogeneity in terms of the mean age of the population

Figure 2 – *Trend of mean age across Italian macro-areas. Years 2000-2022.*



Source: Our elaboration based on ISTAT data

Figure 3 – *Map of growth rate of mean age for Italian provinces between 2002-2022.*



Source: Our elaboration based on ISTAT data

Table 2 presents the results of OLS regression models, each column corresponds to the results of a specific model.

Table 2 – *Results of OLS Regression M1, M2, M3, M4. Year 2002-2022.*

	M1	M2	M3	M4
TFR Italian women	-7.264*** [-8.284, -6.244]	-3.225*** [-4.540, -1.910]		
TFR foreign women	-1.055*** [-1.371, -0.739]		-1.414*** [-1.650,-1.177]	
Percentage of foreigners	0.312*** [0.241, 0.383]			0.203***
SLOW		(baseline)	(baseline)	(baseline)
MEDSLOW		-1.121 [-3.401, 1.159]	-0.953*** [-1.276, -0.594]	0.196*** [0.148, 0.244]
MEDFAST		-2.211 [-5.099, 0.677]	-1.024*** [-1.339, -0.709]	0.454*** [0.350, 0.558]
FAST		-15.205*** [-18.673,-11.737]	-1.479*** [-1.777, -1.181]	1.150*** [0.823, 1.477]
Constant	53.752*** [52.404, 55.100]	54.221*** [52.774, 55.668]	49.590*** [49.340, 49.840]	41.524*** [41.255, 41.793]

* p<0.1; ** p<0.05; *** p<0.001.
Confidence intervals for the coefficient estimates are given in brackets [].

The results of the M1 model indicate that fertility has a slowing effect on the ageing process, since the coefficient relating to the fertility of Italian women (β=-7.26) shows a negative relationship between mean age and fertility. This relationship is also confirmed by the coefficient on the fertility of foreign women (β= -1.05), although the effect of the fertility of native women on the mean age is greater. On the other hand, the foreign presence, expressed by the percentage of foreigners, shows a positive coefficient (β=0.31). This result contrasts with previous research (García-Pereiro, 2018), which showed a negative relationship between mean age and foreign presence. However, we do not interpret this positive coefficient as an increase in the mean age as the number of immigrants increases, but in a different way, which will be explained more clearly in the commentary on the M4 model.

M3 analyses the relationship between the mean age and the TFR of foreign women. Again, there are differences in the effect of the total TFR of foreign women on mean age depending on whether ageing is faster or slower, but they are not as pronounced as in the previous case.

Model M4 relates the mean age to the percentage of foreigners, but rather than seeing the increase in the mean age as a consequence of the increasing foreign presence in the area over time, we see it as an indication that, despite the increase in the percentage of foreigners, this has not been sufficient to halt the ageing process.

Consequently, the beta coefficient indicates that the influence of foreign presence has not been sufficient to offset the effects of ageing. If the beta coefficient had been zero, it would have indicated a situation of perfect compensation between the elderly

population and the foreign population. It should be noted that the coefficient increases in proportion to the speed of ageing in the provinces, indicating that the speed of ageing plays a moderating role in this context. For the provinces in the 'slow' group, the coefficient is neither high nor very far from zero. It is therefore clear that the northern and central Italian provinces, which experienced a slower ageing process over the period considered, also recorded a higher percentage of foreigners. On the other hand, in the southern and island provinces, where the process was more rapid, the percentage of foreigners in the territory was not high enough to mitigate the effects of ageing.

5. Discussion and conclusion

Italy has experienced significant territorial differences in the development of population ageing. Consequently, it is crucial to consider it when studying this phenomenon. (Barile *et al.*, 2022).

At the beginning of the study period (2002), the ageing process divided Italy into two distinct regions: the southern and island provinces, which exhibited younger population structure and the central and northern provinces further along in the ageing process. The literature (Backman & Karlsson, 2024; Golini *et al.*, 2003) indicates that demographic changes occur more rapidly and intensively in previously younger areas. The results of our analysis are consistent with those observed by Golini *et al.* (2003) and Reynoud *et al.* (2018) in their respective research. The provinces that were younger than the others at the beginning of the 2000s exhibited a greater increase in mean age in the subsequent years examined. As a result, the diversity in population structure between the Italian macro-areas diminished, indicating a tendency towards a state of demographic homogeneity with regard to the mean age of the population (Gutiérrez Posada *et al.*, 2018; Kashnitsky *et al.*, 2017).

To answer research question RQ1, namely how fertility and migration contribute to the ageing process, the results of our analysis highlighted the important role of fertility in slowing down this process. According to the research carried out by García-Pereiro and Paterno (2018), the fertility of Italian women influences the mean age more than other demographic phenomena, such as migration. In our research, the influence of the foreign component was analysed through two fundamental aspects: the fertility of foreign women and their number. It turned out that the fertility of foreign women has a slowing effect, although less than that of native women. With regard to numerosity, the positive beta coefficient indicates that the impact of the foreign presence has not been sufficient to compensate for the effects of the ageing process. Despite the increase of immigrants in Italy, they are not enough to reverse the demographic ageing process (Craveiro *et al.*, 2019). Moreover, in provinces where the phenomenon has developed rapidly, a higher percentage of

foreign population is needed to observe significant effects than in provinces where the ageing process has developed more slowly. This raises questions about the sustainability of areas that receive even more immigrants (Bermingham, 2001; Bijak *et al.*, 2006).

With regard to questions RQ2 and RQ3, i.e. whether the contribution of fertility and migration is greater in provinces that have aged faster, the answer is yes. However, the differences in the contribution of the determinants of population structure according to the speed of ageing are more pronounced when fertility is considered than when migration is considered. This could be due to the different impact of the two phenomena on the mean age. Future research could focus on investigating the underlying causes of the different ageing rates in order to design ad hoc policies according to the demographic profile of territories.

One limitation of this research is the use of mean age as a proxy for ageing. Consequently, potential future developments could include repeating the analysis using the median age and a lower level of aggregation to analyse the dynamics of the ageing rate among Italian municipalities.

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